



ESTIMATION OF EMISSIONS FOR PETROL VEHICLES IN SOME ROADS IN MERAUKE CITY

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ABSTRACT

Emissions of motorized vehicles account for a large portion of pollution in big cities. Vehicle growth exponentially significantly increases emissions, in addition to the condition of vehicle feasibility, traffic patterns, city planning that concentrates offices in the city is the cause of more air pollution sources in urban areas. Substances of air pollutants sourced from motor vehicles namely CO causes cancer, SO₂ causes respiratory tract irritation, NO_x causes throat vessel reactivity in asthmatics. This study aims to (1) find out the types of motorized vehicles that pass through the road at the observation point and find out the types of motor vehicles that contribute the most emissions (2) estimate CO emissions from motor vehicles (3) estimate NO_x emissions from vehicles motorized (4) estimating SO₂ emissions from motorized vehicles (5) testing the regression and correlation of the number of motorized vehicles to emissions. The method used in this study is observation / observation, observational data is processed using a calculation formula according to the Regulation of the Minister of Environment No. 12 of 2010. Then the calculation data is carried out by correlation and regression tests.

Keywords: Emissions, Petrol, motorized vehicles.

Cite this Article: Daniel Parennden and Cipto, Estimation of Emissions For Petrol Vehicles In Some Roads In Merauke City, International Journal of Mechanical Engineering and Technology, 10(1), 2019, pp. 326–334.

<http://www.iaeme.com/ijmet/issues.asp?JType=IJMET&VType=10&IType=1>

1. INTRODUCTION

Transportation technology was created to make it easier for humans. Along with the development of the times, transportation technology is growing rapidly, the progress of major cities in the world is supported by the development of transportation technology. The modes of transportation are increasingly diverse, as are the increasing numbers, but on the other side of the development of transportation, an increase in the number of vehicles has negative effects that are harmful to human survival.

Information on the feasibility test of vehicle emissions in 44 major cities in Indonesia that have been published by the Ministry of Environment. 12% of the total 51,314 gasoline vehicles are not feasible, while for diesel vehicles 56.94% of the total 19,962 diesel vehicles, are not feasible. As a result of this condition 54.8% of Jakarta residents suffer from diseases related to air pollution. (M, Zakaria, 2013)

Air pollution is a shared responsibility, because human activity is one source of air pollutants (Kotta et al., 2018), which is a source of air pollution that can be prevented and controlled. One of the human activities that pollute the air is transportation activities. Transportation activities produce emissions / exhaust. Air pollutants derived from vehicle emissions, are caused by the development of the number of vehicles that are fast (exponential). The significant increase in the number of motorized vehicles has resulted in the increasing need for fuel oil, especially diesel fuel and gasoline. The use of a lot of fuel will certainly cause a lot of exhaust emissions. (Devianti Muziansyah et al., 2015; Santoso and Mangkoedihardjo, 2013). The influence of the increasing number of vehicles in traffic volume increases causing congestion, congestion increases CO gas emissions due to incomplete combustion, up to almost 6 times if traffic experiences congestion. In addition, engine life affects the concentration of CO emissions produced by vehicles. The older the vehicle, the greater the concentration of CO emissions produced. This is caused by the engine components (which play an important role in the combustion process) that have experienced a lot of wear and tear, besides, a lot of dirt - dirt that sticks to the air filter. (Devianti Muziansyah et al., 2015).

Motor vehicle emissions are measured in grams per vehicle per km from a trip and are related to several factors such as vehicle type, vehicle age, temperature and altitude thresholds. Vehicles with different ages and types of fuel will produce different emissions. (Yuliastuti et al., 2008). Motorized vehicle emissions on the road are caused by three factors, namely the total volume of motorized vehicles; characteristics of motorized vehicles; general traffic conditions at that time (Zhongan, et.al 2005). According to Zhongan, et al. (2005) the basic formula for estimating emissions using factor emissions is $\text{Emission (g)} = \text{emission factor (g / km)} * \text{Vehicle kilometers traveled (km)}$. For arterial road segments with length L, traffic characteristics are considered constant. Motor vehicles are the main source of air pollution in urban areas and contribute 70% of NO_x emissions, 52% of VOC emissions and 23% of particulates. (Department of Environment & Conservation, 2005)

Carbon monoxide (CO) is a gas that is colorless, odorless, and tasteless. CO gas can be liquid at -1920C. The existence of this gas is largely the result of burning fossil fuels with air, in the form of exhaust gases. Motor vehicle exhaust is also one of the largest CO gas producers in addition to industrial activities. (Wardhana et al., 2001). The effect of sulfur dioxide on human and animal health is disruption of the respiratory tract and eye irritation. At very high concentrations it can cause death. The SO₂ to 38 ppm concentration had occurred in Belgium, resulting in 60 deaths and hundreds of cows and other livestock dying. (Manik, 2007). Nitrogen dioxide is a gas that is grayish red and most important in polluted air. NO reaction with oxygen will increase NO₂. (Wardhana et al., 2001). Problems on environment have been described by results of relevant research (Djamali et al., 2018; Latuheru and Sahupala, 2018; Maulany et al., 2018; Samudro et al., 2011; Warembra and Bahri, 2018).

The increase in the number of motorized vehicles in the city of Merauke also has the potential to affect air quality which is a danger to the health of residents of Merauke city. Based on this, the researcher observed and analyzed the data to determine exhaust emissions based on the number and type of motorized vehicles.

2. METHODOLOGY

Observations were carried out directly on three road segments which were the object of research, namely: Jalan Brawijaya-Brawijaya Circle with a length of 200 meters; Parako-Lingkar Brawijaya Road is 200 m long; and TMP-Circle Brawijaya Road for 200 meters.

The selection of 200 meters of road length is intended so that passing vehicles can still be seen. Parako Road - Brawijaya Circle was chosen because there is a Muslim worship center, fruit market and close to the education center, Jalan Brawijaya Section - The Brawijaya Circle is chosen because it is a crossing from and to traditional markets, Merauke Regional Government office, and TMP road Tomb of the Heroes - The Brawijaya Circle is chosen because it is a crossing from and to terminals, offices, ports. The three road sections have high traffic volume.

Section of Parako-Brawijaya Circle, Brawijaya-Brawijaya Circle, TMP-Brawijaya Circle which is the location of the study is shown in Figure 1 below.



Figure 1. Map of Field Observation Location

Retrieval of data in the form and type of vehicles crossing the road that is the target of the research is carried out directly in the field. The selection of road length that is the target of the study is a road with good and straight conditions that have no turns. This is taken to get a constant average vehicle speed and facilitate observation.

Equations used (Abner Tarigan, 2009)

$$E_p = \sum_{i=1}^n L * N_i * F_{pi}$$

where:

L = The length of the road under study

N_i = Number of type i motorized vehicles that cross roads (vehicles / hours)

F_{pi} = Emission factors for motorized type i (g/km)

i = Type of motorized vehicle (1-n)

E_p = Emission intensity of a segment (g/hour/km)

P = The type of pollutant estimated

Table 1. Exhaust Emission Factors (KemenLH, 2010)

Category vehicle	CO (g/km)	HC (g/km)	NO _x (g/km)	PM ₁₀ (g/km)	CO ₂ (g/km Fuel oil)	SO ₂ (g/km)
Motorcycle	14	5,9	0,29	0,24	3180	0,008
Car (gasoline)	40	4	2	0,01	3180	0,026
Car	32,4	3,2	2,3	0,12	3178	0,11
Bus	11	1,3	11,9	1,4	3172	0,93
Truck	8,4	1,8	17,7	1,4	3172	0,82

3. LINEAR REGRESSION TEST

Test of Correlation between Number of Vehicles to Concentrations of CO, NOX, SO2. The data that has been obtained from the measurements is analyzed by conducting a regression test to see how the number of vehicles (X) influences the concentration of CO, NOX, SO2

(Y) and do linear regression calculations to find out how much influence the value of X on the value of Y. (Wendy C Sihombing 2017).

Description of Correlation Factors:

1. 0 : There is no correlation between two variables
2. 0 – 0,25 : Correlation is very weak
3. 0,25 – 0,5 : Sufficient correlation
4. 0,5 – 0,75 : Strong correlation
5. 0,75 – 0,99 : Correlation is very strong

4. RESULTS AND DISCUSSION

Total Number of Motor Vehicles

Observations were made on the Parako - Brawijaya Circle Road Section, Brawijaya Road - Brawijaya Circle, TMP Road Section - Brawijaya Meter Circle, and the average speed data of vehicles passing ranged from 30-40 Km / hour. The number of vehicles in the three observation locations is as shown in Figure 2.

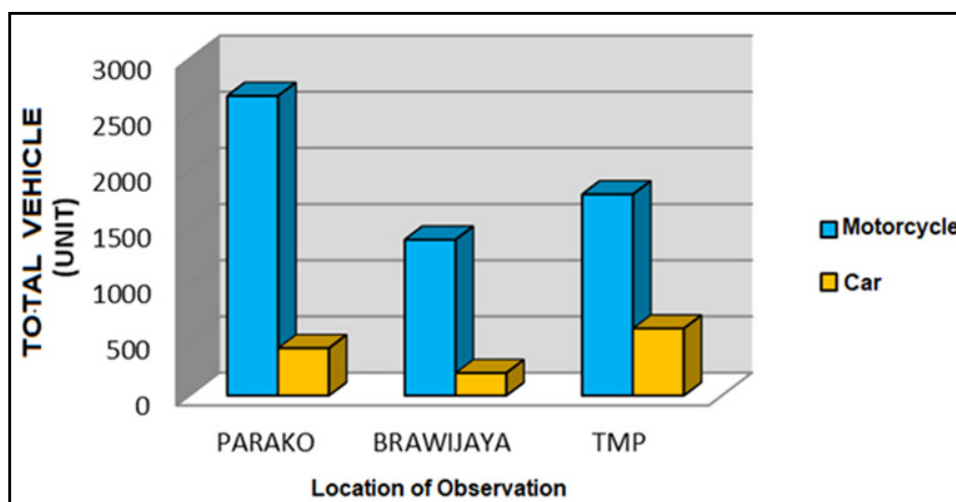


Figure 2 Total Vehicle Charts on the Parako - Brawijaya Road Section; Brawijaya - Brawijaya Circle; TMP - Brawijaya Circle

Based on the graph above it is known that on the three road sections, motorcycle vehicles dominate, and the highest traffic volume on the Parako - Brawijaya Circle segment.

Table 2. Percentage of Average Types of Vehicles on the Parako - Brawijaya Road Section; Brawijaya - Brawijaya Circle; TMP - Brawijaya Circle

Location OKASI	Category vehicle				
	Motorcycle 4 Stroke	Motorcycle 2 Stroke	Private Car	Passenger Car	Goods Car
Parako	85.04%	1.30%	8.80%	0.88%	3.98%
Brawijaya	80.60%	1.30%	10.50%	1.35%	6.25%
TMP	84.80%	1.70%	0.71%	8.81%	3.98%

From the table of the percentage of vehicle types above, it can be seen that from the three road segments the motorbike is dominated by 4 stroke motorbikes. The total 4-stroke motorcycle on the Parako - Brawijaya Circle Road reaches 85.04%, the total 4-stroke motorcycle in the Brawijaya Road - Brawijaya Circle reaches 80.60%, and the total 4-stroke motorcycle on the TMP Road - Brawijaya Circle reaches 84.80%.

Based on the percentage of types of motorized vehicles passing on the three road segments, it is necessary to limit the number of passing two-wheeled vehicles by encouraging residents to use public transportation that can load more passengers so as to reduce air pollution due to exhaust emissions. In line with this, of course, the Government also needs to address this by increasing the lane of public transport vehicles and cheaper public transportation costs so that people will switch to using city transportation which can reduce the volume of vehicles on the highway at the same time.

Total Carbon Monoxide

Calculation of emissions estimation carried out in accordance with observational data obtained results in the form of the amount of CO pollutants estimated to be released when observing 200 meters along the Parako - Lingkaran Brawijaya Road Section; Brawijaya - Brawijaya Circle; TMP - Brawijaya Circle, is as presented in Figure 3.

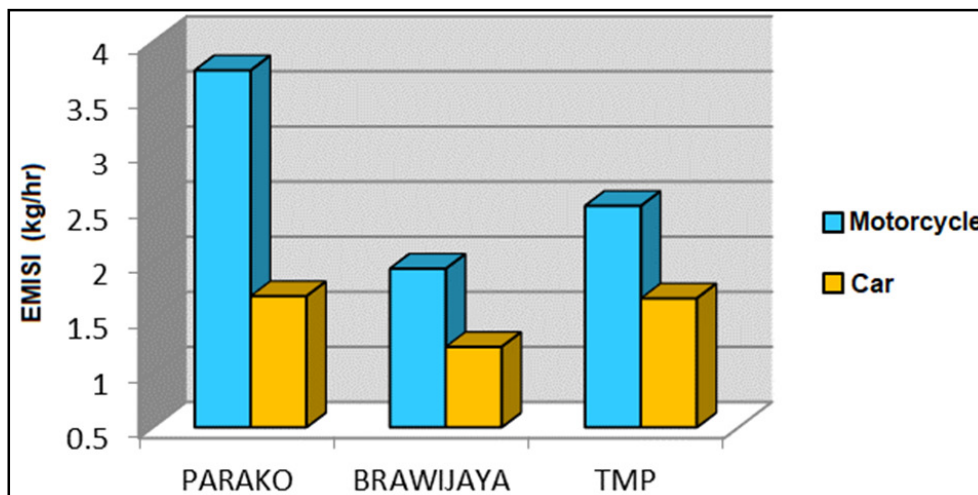


Figure 3. Graph of Total CO Emissions on the Parako - Brawijaya Circle Road Section; Brawijaya - Brawijaya Circle; TMP - Brawijaya Circle

From the picture above, it can be seen that the biggest CO emission is on the Parako - Brawijaya Road segment 3.74 Kg / Hour on motorcycle vehicles and 1.69 Kg / Hour in car

vehicles. More CO emissions are found on the Parako-Circle Bawijaya road segment because there are more vehicles crossing the road, namely 3090 units, while on the TMP road - Brawijaya Circle 3085 units and Brawijaya road - Brawijaya Circle 1695 units. The CO emission factor of motorcycle vehicles is 14 grams / km and CO vehicle emission factors of vehicles are 40 grams / km.

Total Nitrogen Oxide

Calculation of emissions estimation carried out in accordance with observational data obtained results in the form of the amount of NO_x pollutants estimated to be released during observations on the Parako - Circle Brawijaya Road Section; Brawijaya - Circle Brawijaya; TMP - Circle Brawijaya, is as presented in Figure 4.

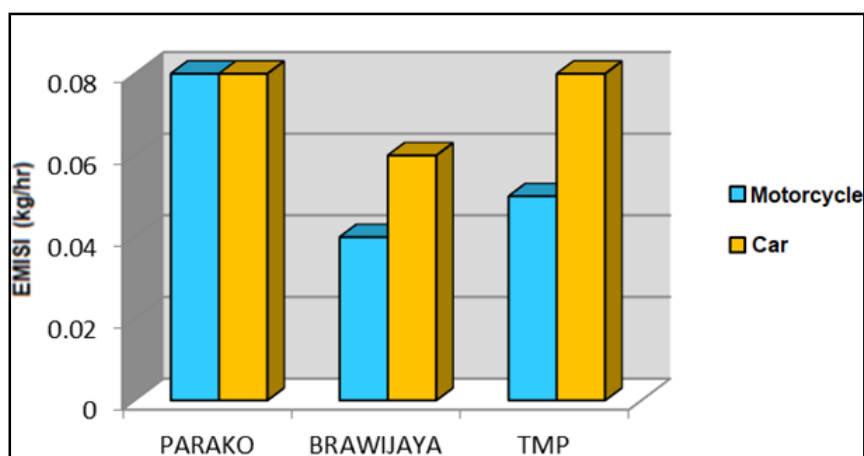


Figure 4 Graph of Total NO_x Emissions on the Parako - Circle Brawijaya Road Section; Brawijaya - Circle Brawijaya; TMP - Circle Brawijaya

From the picture above it can be seen that the biggest NO_x emission is on the Jalan Parako - Circle Brawijaya section 0.08 Kg / Hour on motorbike and car vehicles. More NO_x emissions are found on the Parako-Circle Bawijaya road segment because there are more vehicles crossing the road, which is 3090 units, while the T85 - Circle Brawijaya section of the 3085 units and the Brawijaya - Circle brawijaya road section are 1695 units. NO_x emissions of car vehicles are more than motorbikes because the NO_x emission factor in a car vehicle of 2 grams / km is much greater than the emission factor on a motorcycle, which is 0.29 grams / km.

Total Sulfur Dioxide

Calculation of emissions estimation carried out in accordance with observational data obtained results in the form of magnitude of SO₂ pollutants estimated to be released during observations on the Parako - Circle Brawijaya Road Section; Brawijaya - Circle Brawijaya; TMP - Circle Brawijaya, is as presented in Figure 5.

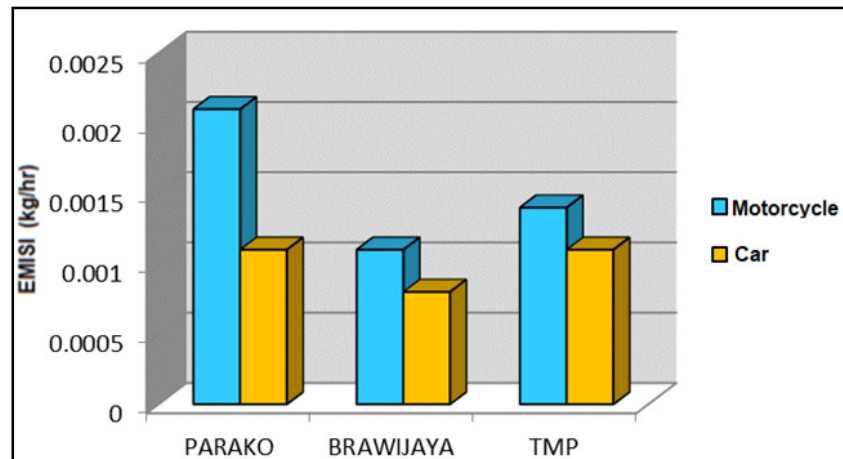


Figure 5 Graph of Total SO₂ Emissions on the Parako - Circle Brawijaya Road Section; Brawijaya - Circle Brawijaya; TMP - Circle Brawijaya

From the picture above, it can be seen that the biggest SO₂ emissions are on the Jalan Parako - Circle Brawijaya section 0.0021 Kg / Hour on motorbike vehicles and 0.0011 Kg / Hour on car vehicles. More SO₂ emissions are found on the Parako-Circle Bawijaya section because there are more vehicles crossing the road, namely 3090 units, while on the Brawijaya-Circle Brawijaya section 1695 units and on the TMP-Circle Brawijaya section 3085 units. Emissions on motorbike vehicles are more than the emissions on car vehicles because the total number of motorbike vehicles on the three road segments is far greater, namely 6724 units and the total number of vehicle cars is 1146 units. SO₂ emission factors for motorbike vehicles and car vehicles are not much different, namely 0.008 gram / km on motorcycle vehicles, 0.026 in car vehicles.

5. CORRELATION AND REGRESSION ANALYSIS

Table 3 Correlation Test and Regression of the Number of Vehicles to CO Concentration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Observation
1	0.835517	0.698088	0.396176	0.879728	3

Based on table 3, it can be seen that the relationship between the number of vehicles to CO concentration is very strong, namely the value of $R = 0.835517$ and the number of vehicles has an effect of 69.8% on the amount of emissions. The rest is influenced by factors outside.

Table 4 Correlation and Regression Test of the Number of Vehicles Against NO_x Concentration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Observation
1	0.867576	0.752688	0.505376	0.879728	3

Based on table 4, it can be seen that the relationship between the number of vehicles to NO_x concentration is very strong, namely the value of $R = 0.867576$ and the number of vehicles has an influence of 75.2% on the amount of emissions. The rest is influenced by factors outside.

Table 5. Correlation and Regression Test of the Number of Vehicles to SO₂ Concentration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Observation
1	0.945924	0.894773	0.789546	0.000491	3

Based on table 5, it can be seen that the relationship between the number of vehicles to NO_x concentration is very strong, namely the value of $R = 0.945924$ and the number of vehicles has an influence of 89.4% on the amount of emissions. The rest is influenced by factors outside.

6. CONCLUSION

- In accordance with observational data of vehicles that dominate / most cross the three road segments, there are motorbike vehicles which are as much as 85.04% on the Parako-Circle Brawijaya road segment, 80.60% on Brawijaya-Circle Brawijaya road segment, 84.80% on the TMP-Circle Brawijaya road section. So that the most emissions are caused by motorcycle vehicles
- The largest total CO emission is found on the Brawijaya Parako-Circle road section 5.43 Kg / Hour, on the Brawijaya-Circle Brawijaya road segment, 3.17 Kg / Hour, and on the TMP-Circle Brawijaya road segment 4.18 Kg / Hour.
- The largest total NO_x emissions are on the Parako-Circle Brawijaya road segment 0.16 Kg / Hour, on the Brawijaya-Circle Brawijaya road segment, 0.1 Kg / Hour, and on the TMP-Circle Brawijaya road segment 0.11 Kg / Hour.
- The largest total SO₂ emissions are on the Parako-Circle Brawijaya road segment 0.0032 Kg / Hour, on the Brawijaya-Circle Brawijaya road segment, 0.0019 Kg / Hour, and on the TMP-Circle Brawijaya road 0.0025 Kg / Hour.
- Based on linear regression test the number of vehicles has a very strong influence on increasing emissions. where the higher the volume of the vehicle, the higher the emissions produced.

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